TRAILER TOW CONNECTOR ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional patent application Serial No. 60/411,709, filed on September 18, 2002 the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to electrical connectors, and, in particular, to electrical connectors for making electrical connections between a vehicle and an apparatus towed by the vehicle.

BACKGROUND OF THE INVENTION

It is commonplace to provide an electrical connector on a vehicle for accepting a corresponding connector that is cable-connected to electrical components of a towed apparatus, e.g. a trailer, boat, etc. Because of the multiplicity of components in vehicles for such things as running lights, brake lights, and signal lights, as well as electric brakes and other auxiliary equipment, the vehicle connector may provide seven or more contact terminals, e.g. arrayed in a circular pattern about a central terminal. The towed apparatus, however, may not require connection to each contact terminal, and thus may include a connector having fewer contact terminals than the vehicle connector.

In such cases, adaptors have been developed for making appropriate electrical connections from a vehicle to a towed apparatus. For example, 7-way (on vehicle) to 4-way (on towed apparatus) adaptors are well known. Alternatively, vehicles have been provided with multiple connector types to eliminate the need for an adaptor. In one example, a vehicle may be provided with both 7-way and 4-way connectors, each having their own wiring harness and connections to the vehicle electrical system.

Cost and water corrosion have, however, been persistent problems with known vehicle connector types. Four way, connectors, for example, are typically encapsulated with soft rubber and include a molded, flexible cover to protect the connector when no plug is inserted in the socket. These four-way connectors are susceptible to water intrusion through the cover, as well as through the exit location of the wires at the rear of the connector. This water intrusion typically causes corrosion of the four-way contacts. In addition, in the case where multiple vehicle connectors are provided to avoid the use of an adaptor the separate wire harnesses for the connectors and the separate connector components are costly.

There is, therefore, a need for a connector configuration that may be cost-effectively produced and is resistant to corrosion caused by water intrusion. There is also a need in the art of a combined connector configuration that may be cost-effectively produced and is resistant to corrosion caused by water intrusion.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, together with other objects, features and advantages, reference should be made to the following detailed description which should be read in conjunction with the following figures wherein like numerals represent like parts:

Figure 1 illustrates an exemplary four-way connector consistent with the invention in a cross-sectional view;

Figure 2 is an exploded diagram of the exemplary connector shown in Figure 1;

Figure 3 is a perspective view of the exemplary four-way connector of Figure 1;

Figure 4 is a top perspective view of the exemplary four-way connector shown in Figure 1;

Figure 5 shows the exemplary four-way connector of Figure 1 in a top elevation view;

Figure 6 is a rear elevation of an exemplary four-way connector consistent with the present invention;

Figure 7 shows a front elevation of an exemplary four-way connector consistent with the present invention;

Figure 8 shows a side elevation of an exemplary four-way connector consistent with the present invention;

FIG. 9 is a top elevation of an exemplary four-way connector consistent with the present invention with the cover not attached;

Figure 10 shows a second exemplary configuration of a four-way connector consistent with the present invention in cross-sectional view;

Figures 11a through 11c illustrate an exemplary combination connector consistent with the present invention, and an exemplary terminal/contact assembly consistent with the present invention;

Figure 12 is a perspective view of an exemplary combination connector consistent with the present invention;

Figure 13 is a perspective view an another exemplary combination connector consistent with the present invention;

Figures 14a though 14 e show an exemplary terminal layout in various views for a combination connector consistent with the present invention;

Figure 15 is an enlarged perspective view of a spring finger feature that may be used to connect terminals in a combination connector consistent with the present invention;

Figure 16 is an exemplary wiring/contact diagram for a seven-way connector;

Figure 17 is an exemplary wiring/contact diagram for a four-way connector;

Figures 18a and 18b depict an exemplary combination connector consistent with the present invention in back-side elevation and sectional view;

Figure 19 is an enlarged perspective view of a four-way connector portion consistent with the present invention;

Figures 20 and 21 depict a combination connector having a common hinge design consistent with the present invention;

Figures 22a-22c depict an exemplary spring mechanism that may be used with a common hinge design consistent with the present invention;

Figures 23 and 24 depict a plan view of an exemplary connector having a symmetrical mounting footprint;

Figure 25 is a perspective view of an exemplary locking tab consistent with the present invention;

Figures 26-29 variously show an exemplary locking tab deployed on a combination connector consistent with the present invention;

Figure 30 schematically depicts an exemplary locking tab connected to a combination connector via a living hinge;

Figures 31a and 31b respectively show an exemplary single-stage and an exemplary dual-stage locking tab consistent with the present invention;

Figure 32 is a representational drawing showing a locking tab deployed on a combination connector in a manner consistent with the present invention;

Figure 33 is an enlarged perspective view of a female terminal consistent with the present invention;

Figures 34 through 36

DETAILED DESCRIPTION

The present invention relates generally to electrical connector assemblies. According to a first aspect, the electrical connector includes a body portion and a cover portion biased to a closed position. This aspect of the present invention is described with reference to a four-way connector as may be used for making electrical connections between a vehicle and an apparatus towed by the vehicle. Those skilled in

the art, however, will recognize that the present invention may be utilized for a host of other application. Thus, it is to be understood that the present invention is not limited to the illustrated exemplary embodiments described herein. Rather, the present invention may be incorporated in a wide variety of devices without departing from the spirit and scope of the present invention.

Turning to Figures 1 through 10, an exemplary connector 100 consistent with the present invention is shown. The connector generally includes a body portion 102 and a cover 108. The body portion 102 contains four electrical contacts, including three female barrel contacts 104, and a plug type contact 106. The body portion 102 may, of course, contain more or fewer contacts that may be of varying styles known to those having skill in the art.

In the illustrated embodiment, as best seen in Figures 3 and 4, the cover 108 may be pivotally connected to the body portion 102 about the long edge of the connector body 102. According to the exemplary embodiment, pivotal connection may be accomplished via a pin 112 passing through corresponding clevises on the cover 108 and body portion 102. The cover 108 is biased toward a closed configuration. In the illustrated embodiment, a cover spring 110 may be provided over the pin 112 to bias the cover 108 toward a closed configuration. In the exemplary embodiment, the cover spring 110 is a torsion spring disposed over the pin 112. Those having skill in the art will appreciate that numerous other spring configurations or biasing mechanisms may suitably be used to bias the cover 108 toward a closed configuration.

As shown, for example in Figure 3, the inside of the cover 108, i.e., the side facing the connector body portion 102, may include a sealing wall 114 extending therefrom. The body portion 102 may include a corresponding groove 116 formed by opposed walls 118, 120 extending from the body portion 102. When the cover 108 is in a closed configuration the sealing wall 114 may be received in the groove 116 to seal the housing from entry of water and other contaminants.

The spring loaded cover 108 provides an advantage over conventional rubber caps that tend to inadvertently disengage in that the spring loaded cover 108 resists opening an exposing the connector 100 to water and contaminants. The above-described connector 100 may further be improved by using an elastomeric or foam seal on at least one mating interface between the cover 108 and the connector body portion 102. For example, an O-ring may be provided in the groove 116, such that when the cover 108 is in the closed configuration, the sealing wall 114 is urged against the O-ring. Similarly, a seal may be provided on the portion of the cover defined by the sealing wall. Accordingly, when the cover 108 is in the closed configuration, the inside wall 120 may be urged against the seal.

The connector may also include an integral sealed connector on the back end so water intrusion around the wires is minimized or eliminated. The back end of the sealed connector may include an elastomeric block that is fitted around wires entering the connector, wherein the elastomeric block is compressed by an opening in the back end, thereby forming a tight seal. Additional and alternative sealing configurations on the back end will be apparent to those having skill in the art.

While not illustrated, it should be understood that alternatively, the body portion may include a single upstanding sealing wall and the cover may include a pair or spaced apart walls defining a groove for receiving the sealing wall therebetween. Consistent with yet another variation, the groove may be formed as an indentation in the body portion or cover, as opposed to being defined by a pair of spaced, upstanding walls.

Turning to Figure 10, a second exemplary connector 200 is shown in a cross-sectional view. Similar to the first exemplary embodiment, the connector 200 includes a body portion 202 including a plurality of contacts 204, 206. The connector 200 also includes a cover 208 that is pivotally coupled to the body portion 202. The cover 208 is biased toward a closed position, e.g., by spring 210. Additionally, the cover 208 may include a sealing wall 214 the may be received in a groove 216 formed by opposed walls 218 and 220 extending from the body portion 202. However, in the case of the second exemplary connector 200, the cover 208 is pivotally connected to the body portion 202 about a short side of the body portion.

Those having skill in the art will appreciate that a connector consistent with the first aspect of the invention is susceptible to numerous alterations and modifications, including, but not limited to, the shape of the connector body and the shape of the cover. Furthermore, various alternative and additional means for pivotally connecting the cover to the body portion will also be understood by those having skill in the art, as will various additional and alternative means for biasing the cover toward a closed configuration.

According to another aspect, the present invention is directed at a combination connector, shown in various views in Figures 11 through 19. The combination connector combines two or more electrical connectors having different configurations and/or number of electrical contacts using a common wiring harness. In the exemplary context of an electrical connector between a vehicle and an apparatus towed by the vehicle, a connector consistent with the present invention may provide either a conventional seven-way electrical connector or a conventional four-way electrical connector via a single vehicle wiring harness. Those skilled in the art, however, will recognize that the present invention may be utilized for a host of other application. Thus, it is to be understood that the present invention is not limited to the illustrated exemplary embodiments described herein. Rather, the present invention may be incorporated in a wide variety of devices without departing from the spirit and scope of the present invention.

Referring to Figure 12, an exemplary electrical connector 300 consistent with the present invention is shown. The illustrated exemplary connector 300 generally includes a seven-way connector interface portion 302 and a four-way connector interface portion 304 on the same housing 306.

Referring to Figure 16, an exemplary seven-way electrical connector wiring/contact diagram for a vehicle towed apparatus is shown. According to the wiring/contact diagram, the electrical contact in position 1, located at 9 o'clock in the illustration, may provide the electrical connection for controlling the left-hand stop/turn light. Similarly, as shown the contact at position 2 may be the ground

contact. The remaining contact positions, 3 through 7, according to the exemplary wiring/contact diagram are for the electric brakes, right-hand stop/turn light, auxiliary, running lights and reverse indicator respectively.

Referring to Figure 17, a corresponding wiring/contact diagram for an exemplary four-way connector interface is shown. From left to right the contacts of the exemplary connector are for the ground, running lights, left-hand stop/turn, and right-hand stop/turn.

From Figures 16 and 17 all of the electrical connections provided by the four-way connector interface are also provided by the seven-way connector interface. Consistent with the present invention, the circuits of the seven-way connector interface 302 and the four-way connector interface 304 are combined in a manner that necessitates only a single wire harness. That is, one combined connector accommodates all of the circuits. According to one aspect, the present invention achieves the combination of circuits by putting the terminal bus at two or three different levels. This multi-level terminal bus arrangement obviates the need for a printed circuit board. Additionally, the connector may be suitable for high current applications.

Referring to Figures 14a through 14e, an exemplary terminal layout for the connector 300 is shown in top, front, right, left, and perspective views. The terminals 310 of the four-way connector interface are coupled to the terminals 312 of the seven-way connector interface, thereby forming a terminal bus. As best seen in Figure 14d, the terminals 310 are on multiple layers to accomplish circuit connections with terminals 312.

Turning next to Figure 15, the terminals 310 of the four-way connector interface and the may be secured to the terminals 312 of the seven-way connector interface by spring finger features 314. In the illustrated embodiment, the spring finger features 314 generally include a surround portion 316 including an opening 317. The spring finger feature 314 further includes a plurality of tabs 318 extending into the opening 317 of the surround portion 316.

Connection between the terminals 310, 312 may be made by inserting the terminal 312 at least partially though the opening 317. The tabs 318 may extend into the opening 317 sufficiently that tabs 318 are in contact with the terminal 312 when the terminal is at least partially received in the opening 317. Advantageously, the tabs 318 may extend into the opening 317 far enough that the tabs 318 are at least partially deflected by the presence of the terminal 312 in the opening. Such deflection of the tabs 318 by the terminal 312 may result in either elastic deformation or plastic deformation of the tabs 318.

The use of spring finger features for securing the terminals of the respective connector interfaces ensures reliable connections between the terminals. Additionally, the spring finger connection features may allow the terminals to be assembled after molding of the connector, without compromising the ability to produce a reliable connection between the terminals.

Referring to Figure 19, a detailed view of one exemplary embodiment of the four-way connector portion 304 is shown. In the illustrated embodiment, the female barrel contacts 402 of the four-way connector interface 304 include walls 404 around the

contacts 402. The walls 404 may serve to isolate the individual contacts 402 and/or to protect the contacts 402. As illustrated, the walls 404 may include webs 406 extending between adjacent walls 404.

In some embodiments consistent with the present invention, the walls 404 may include slots or windows 408. The windows 408 may allow the female contacts 402 to expand when receiving a mating plug by allowing the walls 404 to deflect. As illustrated, the windows 408 may be arranged orthogonal to the line of the contacts 402, thereby maintaining electrical isolation between the contacts 402 even when they are expanded.

Referring particularly to Figures 13 and 18b, a skirt 420 may be added around at least a portion of the connector 300. The skirt 420 may provide the connector 300 with a uniform mounting surface about the perimeter of the connector 300. The skirt 420 may, therefore, eliminate the need to provide a mounting bracket where the connector sits.

It should be understood that the features described above in connection with FIGS. 1-10 may be incorporated into the four way portion of the combined connector of FIGS 11-19. Advantageously, therefore, there is provided a combined connector that eliminates the need for an adapter, while allowing cost-effective production and resistance to corrosion.

According to another aspect, a combination connector consistent with the present invention may include a cover, such as described with reference to Figures 1-10, protecting each connector portion of the combination connector. More particularly, the combination connector may include a cover for each connector portion wherein opening

one cover to access one connector portion inhibits simultaneously opening and accessing another connector portion. This aspect may reduce the likelihood that more than one connector will be used at the same time. Accordingly, the chance of exceeding a maximum current draw for the connector wire harness may be reduce, thereby reducing the occurrence of a blown fuse or fire resulting from excessive heat build up.

Referring to Figures 20 and 21, an exemplary combination connector 500 having a cover arrangement consistent with this aspect of the invention is illustrated. The exemplary connector 500 includes a first connector portion 502, such as a seven-way connector interface, and a second connector portion 504, such as a four-way connector interface. Each connector portion 502, 504 includes a respective cover 506, 508 which may be opened to access the connector portions 502, 504.

In the illustrated embodiment, the covers 506, 508 are pivotally attached to the connector 500 via a common hinge. The common hinge may include a hinge pin 510 extending through a clevis 512 on the connector body 501 and through each respective cover 506, 508. The hinge arrangement may be similar to the hinge arrangement of the cover illustrated in Figures 1 though 10.

Similar to the hinge arrangement described above, preferably each cover 506, 508 is spring biased toward a closed configuration. Because both of the covers share a common point of rotation and hinge pin 510, a single spring may advantageously be used to bias both of the covers 506, 508 toward respective closed configurations. Referring to Figures 21a though 21c, an exemplary spring 514 configured to simultaneously bias both covers 506, 508 is shown. The spring 514 may be generally

configured as a torsion spring. The spring 514, however may include a bight 516 or extending loop in the central part of the spring 514. In the manner of a conventional torsion spring, the spring 514 may also include extending ends 518, 520. The bight 516 may engage and bias one cover 504, while the end 518, 520 engage and bias the other cover 502.

Still referring to Figures 21a-21c, in the free or unstressed configuration of the spring 514 the bight 516 and ends 518, 520 may be angled at least slightly downward. In the pre-set position, i.e., installed position, shown in Figure 21b, the spring 514 is slightly stressed, thereby urging the respective covers 506, 508 each toward a closed configuration. As shown in Figure 21c, the spring may be further flexed allowing the covers 506, 508 to be opened.

It should be appreciated that when one cover, e.g., 506, is opened, the stress of flexing the spring 514 is transmitted to the other cover 508, thereby increasing the closing force action on the cover 508. It, therefore, requires greater force to open both covers at the same time than the force required to open only a single cover. The use of a single spring 514 consistent with the exemplary embodiment, therefore, may further inhibit opening both covers 506, 508 at the same time.

While the use of a single spring is more cost effective than using two individual springs, and may provide an impediment to opening both covers at the same time, those having skill in the art will appreciate that the objects of the this aspect may also be accomplished using two or more springs.

Referring to Figures 23 and 24 it may be advantageous to configure the combination connector 500 as a symmetrical package from a mounting perspective. In the illustrated embodiment, while the covers are not the same size and shape and the hinge is not located in the center of the connector 500, the overall footprint of the connector 500 is symmetrical. This configuration imparts greater mounting flexibility. As shown, the same mounting features may allow the connector 500 to be rotated 180 degrees without necessitating different mounting features.

As best shown in Figures 28 and 32, the connector 602 may utilize snap-fit features 610, 612 for mounting the connector 602, e.g., to a mounting feature 640, such as a bracket, bumper, etc. The snap-fit features 610, 612 may be disposed on the connector housing 608 and extending therefrom. In operation, the connector 602 may be inserted into a mounting feature 640 causing the snap-fit features 610, 612 to resiliently deflect, e.g., toward the connector body 608 in the illustrated embodiment, as a protrusion portion 642 passes the mounting feature 640. Once the protrusion portion 642 has cleared the mounting feature 640, the snap-fits 610, 612 resiliently recover, whereby an upper surface of the protrusion portion 642 is disposed adjacent the mounting feature and inhibits extraction of the connector.

Turning to Figures 25 through 32, a locking tab 600 is shown that may be used in conjunction with a combination connector 602. When installed, as shown, e.g., in Figures 26-29, the locking tab 600 may inhibit removal of the connector 602 from a vehicle mounting bracket (not shown).

As best seen in Figures 26, 28, and 32 when the locking tab 600 is assembled to the connector 602 the two support legs 604, 606 are positioned between the connector body 608 and the connector snap-fits 610, 612. Accordingly, once the locking tab 600 is in position the connector snap-fits are inhibited from deflecting to allow the release of the connector 602 from the vehicle mounting feature. The center snap feature 616 of the locking tab 600 may be received in a corresponding feature of the connector. The center snap feature 616 may retain the locking tab to the connector 602, thereby preventing easy removal of the locking tab 600, itself, from the connector 602.

The center snap feature 616 of the locking tab 600 may be provided for either single-stage operation or dual-stage operation. As schematically illustrated in Figure 31a, a single-stage locking tab 600 may include a center snap feature 616a having only a single barb 618. Accordingly, the center snap feature 616 is either not engaged with corresponding housing member 620, or is fully engaged with housing member 620, as shown.

Referring to Figure 31b, a dual-stage center snap feature 616b is shown. The dual-stage center snap feature 616b includes two barbs 618a, 618b. When only the first barb 618a is engaged with the housing feature 620, the support legs 604, 606 are disposed between the connector body and connector snap-fits, but the locking tab is retained to the connector 602. Accordingly, when the dual-stage center snap feature 616b is in a fist stage of engagement, the locking tab is retained to the connector 602 and the connector snap-fits may be freely deflected. Once the connector 602 has been mounted in a vehicle mounting bracket, the locking tab 600 may be fully engaged,

thereby positioning the support legs 604, 606 between the connector housing and the snap-fits, thereby preventing deflection of the snap-fits and the removal of the connector 602 from the mounting bracket.

While the dual stage locking tab may retained to the connector without fully engaging the snap-fits, additional accommodations are available in the case of a single-stage locking tab. A living hinge or tear-away feature may be used in conjunction with a single-stage locking tab to prevent separation of the locking tab from the connector before the locking tab is deployed, e.g., before installation of the connector on a vehicle. Referring to Figure 30, an exemplary embodiment of a locking tab 600 retained to a connector 602 by a web 630 of plastic. Desirably, the web 630 may have a small cross-sectional area, may be scored, etc. so that the locking tab may be readily separated from the connector 602.

Consistent with this aspect of the invention, when a connector 602 is to be mounted to a vehicle, the locking tab 600 may be separated from the connector 602, as by cutting, tearing, breaking, etc. The connector 602 may be disposed in the mounting bracket such that the connector 602 is retained in position by the connector snap-fits 610, 612. The locking tab 600 may then be deployed to prevent deflection of the snap-fits 610, 612 and extraction of the connector 602 from the vehicle mounting bracket.

Additionally, the locking tab may be formed having an undercut region. The undercut region may provide access by a tool, such as a screw driver, for removal of the locking tab to facilitate the removal of the connector.

According to another aspect, the invention provides a female terminal or contact that may provide improved life span. An exemplary terminal 700 consistent with the present invention is shown in Figure 33. The terminal 700 generally comprises a cylindrical member 702 having a longitudinal split 704 therein, to facilitate expansion of the terminal 700 upon insertion of a plug (not shown). The distal end of the terminal 700 may include a circumferential indentation 706. A collar 708 is adapted be disposed in the indentation 706.

The collar 708 may be formed from a resilient material, e.g., spring steel, or may be formed from a higher modulus material than terminal cylindrical member 702. As shown, the collar 708 may be a generally cylindrical member, and may also include an axial split 710. Alternatively, the split may be formed as a helical split. In either case the inside diameter, d, of the collar 708 is capable of expanding. With this objective in mind, it should be understood that the collar may also include a helically wound wire or strip.

The collar 708 resists the expansion of the cylindrical member 702. When the collar is formed of a resilient material, the collar 708 may provide greater, and more consistent contact force between the terminal 700 and an inserted plug over the life of the terminal. Additionally, the collar 708 limits spreading of the split 704 in the terminal 700, which otherwise may limit the contact area between the terminal and a plug and reduce electrical contact/life. The use of a collar 708 may facilitate the insertion and extraction of a plug by maintaining a more uniform inside diameter, d, over the life of the terminal.

As discussed previously, a combination connector consistent with the present invention may include a terminal bus that is susceptible to assembly after molding the connector. For example, in the context of a combination 4-way interface and 7-way interface connector, the terminals may be connected using spring finger features.

As illustrated in Figures 34 through 36, at least one of the four-way terminals 802 may be inserted molded with the connector body 800. After molding, a terminal 804 of the seven-way interface may be mechanically installed into the socket housing 806. When the seven-way terminal 804 is mechanically installed into the socket housing 806, the four-way terminal 802 and the seven-way terminal 804 are electrically coupled to one another. Once the seven-way terminal 804 is installed in the socket housing 806, the terminal 804 may be mechanically retained, for example, using an adhesive or heat staking, etc.

As previously discussed, electrical coupling between the four-way terminal 802 and the seven-way terminal 804 may advantageously be accomplished using a spring finger feature. Figure 35 illustrates a top and sectional view of an exemplary spring finger feature 820 consistent with the present invention. In the illustrated embodiment, the four-way 802 terminal may define an aperture 822 sized to receive at least a portion of the seven-way terminal 804. The four-way terminal 802 may further include a plurality of spring fingers 824 projecting into the aperture 822 and in contact with the seven-way terminal 804. In the illustrated embodiment, three spring fingers 824 are in contact with the seven-way terminal 803, although more or less spring fingers may be used.

As illustrated in the sectional view of Figure 35, preferably the spring fingers 824 project far enough into the aperture 822 such that when the seven-way terminal 804 is installed into the aperture 822 the spring fingers 824 are caused to bend or deflect. This may ensure that a secure electrical connection is made between the spring fingers 824 and the seven-way terminal 804. Desirably, the deflection or deformation of the spring fingers 824 is an elastic deformation, thereby providing a very secure electrical connection. Plastic deformation of the spring fingers 824, however, may also provide satisfactory electrical connection between the spring fingers 824 and the seven-way terminal 804.

Turning to Figure 36, an alternative spring finger feature is illustrated. The four-way terminal 902 may include an "S" or reverse "S" slit 904. When the seven-way terminal (not shown) is installed the tabs formed by the slit 904 may deflect in response to the insertion force, thereby forming a secure mechanical and electrical connection between the terminal 902 and the seven-way terminal.

It should also be understood that the various features and aspects of the exemplary connectors described herein may be combined with one another. Furthermore, the features and aspects of the invention herein are susceptible to use with other electrical connectors in addition to the exemplary seven-way and four-way electrical connection between a vehicle and a towed apparatus.

The embodiments that have been described herein are but some of the several which utilize this invention and are set forth here by way of illustration, but not of limitation. It is obvious that many other embodiments, which will be readily apparent

to those skilled in the art may be made without departing materially from the spirit and scope of the invention.